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Culture and Diseases of DELPHINIUMS

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DELPHINIUMS are popular garden flowers of the genus *Delphinium*. The annual species are called larkspurs; the commonly grown perennials are usually known as delphiniums among gardeners.

The annual kinds are what are known as winter annuals. They are of two types, the rocket or spikelike and the candelabrum, both types having white varieties and many shades of blue and a few yellow and pink sorts.

The perennials grow most vigorously in cool weather. Some of them become dormant after flowering and remain so till early spring. Most of the others become semi-dormant during hot weather. Pushing these into growth during their natural rest period is often a cause of lack of success with them.

A deep, well-drained but retentive soil is important, preferably neutral or somewhat alkaline.

Propagation in this country is mostly from seed, which should be sown promptly after ripening. Plants may be divided in spring, late summer, or early fall. Occasionally propagation is from cuttings of new shoots 2 or 3 inches long in the spring.

If springs are long and cool, planting may be done in early spring, but otherwise late summer or early fall is better.

Delphinium failures more often result from uncongenial cultural conditions than from parasitic or disease-inducing organisms. This applies especially to root and crown rots, which are primarily due to climatic inadaptation, soil deficiencies, and faulty drainage. However, the crown and stem rot caused by the fungus *Sclerotium rolfsii* attacks vigorous plants growing under favorable conditions after the soil has become infested by previous culture of delphiniums or other susceptible plants. Rotation of plantings and soil disinfection afford the only remedy.

Leaf spot and mildew are usually associated with unhygienic cultural conditions, such as prolonged maintenance of a delphinium bed without renewal, and with damp, shady sites and crowded plantings.

Perennial delphiniums are sometimes affected with systemic diseases of the virus type causing leaf mottling and possibly streaking of foliage, stems, and flowers. Renewal of plantings from seed affords an effective remedy, but where vegetative propagation is practiced, affected plants must be promptly detected and eliminated.

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CULTURE AND DISEASES OF DELPHINIUMS

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INTRODUCTION

DELPHINIUMS are popular showy annuals and perennials, mostly in blue and white, although there are red and yellow species. They are natives of the North Temperate Zone, and several species are found in the United States. The annuals are usually known as larkspurs. A few of the perennials that have been much improved by selection are what is usually meant by "delphinium" among gardeners. Several kinds are available for many different purposes: some are useful in borders, others for cutting, others for naturalizing, and still others in rock gardens.

Delphiniums are chiefly cold-weather plants as the annuals are really winter annuals that in nature usually start in the fall and overwinter as small plants and complete their life history early in the spring. This hardiness gives rise to the garden practice of sowing the seed in late fall for spring germination, for if it is warm in the fall and the seeds germinate they usually survive the winter. The perennials likewise are most vigorous in cool weather. In addition to being dormant during the winter, many are dormant also in hot weather. Some die to the ground as soon as seed is formed and remain so until the following spring. Others rest in summer and make a fall growth. This strong tendency toward summer dormancy often makes them unsatisfactory in a mixed border where a good appearance throughout the summer is desired. Ignoring this natural tendency may be the cause of some of the difficulties encountered in their cultivation.

ADAPTATION

Some kinds of delphiniums are suited to culture in practically all of the United States except the hot arid regions, although some are more widely adaptable than others. For best results most of them should be grown in full sunshine, but when grown in regions beyond those to which they are best adapted, varieties of the more highly

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developed perennial species are more likely to succeed in partial shade if free from root competition. The principal species from which these perennial varieties have been derived are *Delphinium grandiflorum* L., *D. hybridum* Steph., and *D. formosum* Boiss. and Huet. They are most at home in cool moist places, such as the Puget Sound section and southward near the coast, on the western slopes of the Coast Range Mountains and the Sierra Nevada, and in many locations in the Rocky Mountains. They also thrive in the neighborhood of the Great Lakes and eastward through most of New York and New England and in most of the Appalachian Mountain region. These areas approximately correspond to those shown on the map (fig. 1)

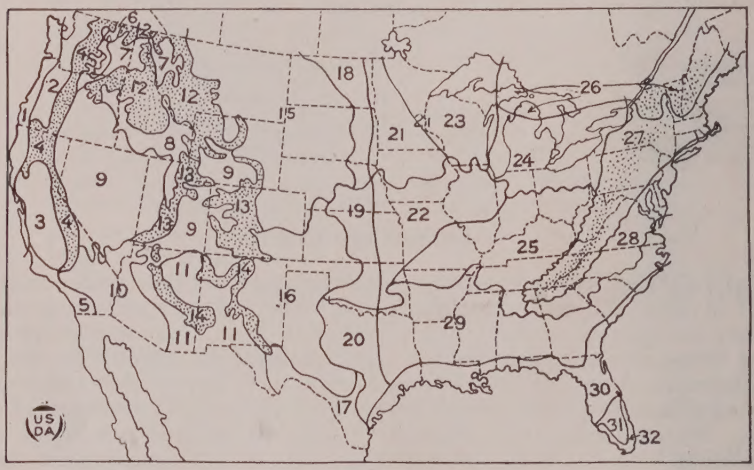

FIGURE 1.—Map of the United States showing division into regions according to growing conditions for plants. Regions are indicated by numbers within heavy border lines. The stippled areas are mountain regions.

as regions 1, 2, a little of region 4, many parts of regions 12, 13, and 14, the northeastern and eastern parts of region 23, and regions 24, 26, and 27.

SOIL

For their best development, delphiniums require a deep, well-drained soil and one that is retentive of moisture, fairly rich, neutral or somewhat alkaline, but if acid, only slightly so. The drainage must be good, or root rot or other difficulties may be serious. If the soil is only fairly well drained, beds raised about 6 inches are often a great help. As sloping ground is usually better drained than flat land, beds are not so likely to be required in such situations. Soils that contain an abundance of organic matter and are deeply prepared are better drained than other soils. A well-enriched sandy loam is especially good. Raised beds are frequently inadequate to provide sufficient drainage on heavy soils, in which case underdrainage should be provided either by tile drains 12 to 20 feet apart or by a 1-foot layer of stones 2 feet under the surface, provided with an adequate outlet to permit the water that reaches the stones to drain away promptly. The stones should be covered with inverted sods and 2

feet of prepared soil (fig. 2). This soil should be similar to that known to florists as medium potting soil. It is made of composted manure, sods, and good soil in about equal parts, with half as much sand added to make the soil porous if the original soil is heavy.

In regions where the soils are naturally acid it would be well to add lime, the amount depending on the acidity of the original soil. From the Missouri River eastward, or from somewhat east of the western edges of regions 21, 22, and 25 (fig. 1) the soil is mostly acid, and it is usually safe to add lime unless heavy applications of it have been made recently. For accurate information on the acidity of soils, implements have been devised which use dyes that are changed in color by the acidity. These may be obtained from leading seed houses and dealers in garden supplies.

Deep soils may be made suitable for delphiniums by incorporating an abundance of compost or fresh strawy manure. Manure with sawdust or planer shavings should be avoided because of possible injury to the plants, and lime should be used with any soil that contains moss peat or similar materials. Lime at the rate of 1 to 2 pounds for 20 square feet of area is advisable also on lands known to be acid.

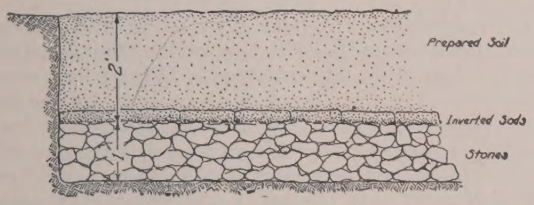

FIGURE 2.—Cross section of a specially prepared bed suitable for delphiniums in land not naturally well drained.

Soils that are too shallow may be made deeper by throwing the topsoil to one side, working manure or compost into the subsoil for 10 or 12 inches, and then replacing the topsoil.

PROPAGATION

Annual delphiniums are grown from seed, but in Europe many varieties of the perennials have been produced and named, which must be propagated vegetatively. In the greater part of the United States vegetative propagation has not proved satisfactory; the usual practice is to secure seed from the better varieties and grow seedlings. These are usually inferior to the parent but prove more satisfactory under the conditions prevailing in this country, and account for the general lack of named varieties.

Seeds should be sown in well-prepared beds of good fibrous loam, which has been made neutral, or nearly so, by lime. Seeds of the annuals may be sown in the fall or may be started indoors early, or outdoors as soon as the ground may be worked. They are slow to germinate. Seed of the perennials may be sown either in late summer or spring, as with other perennials. If started very early indoors, they may be brought into flower the first year.

Delphinium seed should be planted promptly after ripening, as it does not keep well. If it must be kept, it should be put in a stoppered

bottle or a covered jar in a cool place. Old seed either does not germinate or produces weak plants subject to disease.

Perennial delphiniums may be propagated vegetatively by cuttings or by division. Cuttings should be made in the spring when young shoots are 2 or 3 inches long, cutting them with a heel and using a sharp knife. The cut surfaces should be dusted with charcoal. It is best not to attempt to save the part of the plant from which cuttings have been taken. Some English growers prefer to take the "eyes" from the crown before they break into leaf. Either type of cutting should be planted in pots or a coldframe and kept in a close atmosphere by covering with glass and given partial shade until rooted. Bottom heat often helps these early cuttings. Cuttings from hollow stems are not satisfactory. Cuttings may also be made of the second growths that start after the first blooming.

Plants may be divided in the spring, in late summer, or in early fall, depending on the latitude. The new plants should consist of at least three or four shoots, and all dead roots should be cut away. The plants may be treated in this way every 2 years if desired.

PLANTING

Perennial delphiniums are best planted in the spring in regions where the ground dries sufficiently early for the planting to be done several weeks before hot, dry weather. Where hot weather follows soon after the ground is dry enough for handling, spring planting is less satisfactory. However, they are also satisfactorily moved in late summer and fall, 2 months before hard freezes may be expected. The fleshy roots should be handled carefully, so as to avoid bruising them, and they should be set only enough deeper than they grew previously to allow for the settling of the soil.

CARE AFTER PLANTING

Both the perennial and annual sorts should be given clean culture. As flowering time approaches, it is well to provide a good mulch between the plants, preferably cow manure or composted stable manure. Some cultivators make this application after the flower stalks of the first crop of flowers are removed.

Another application of manure should be made about the time of the first freezing weather, but it should be kept well away from the crowns of the plants. The ideal time for application is when the ground is first lightly frozen. The manure thus applied should be combined with the soil in early spring as soon as possible after danger of hard freezing weather is past and the ground is dry enough to work.

As soon as the flowers of the main stalk wither, they should be removed. When the flowers on the side shoots wither, they too should be cut within a foot of the ground. In this way two and sometimes three crops of flowers are possible in a season. Some gardeners also head back part of their plants before the first blooming so as to cause them to flower between the usual times.

KINDS FOR PLANTING

There are two general types of larkspur or annual delphinium, the rocket or spikelike forms, derived principally from *Delphinium ajacis* L., and the candelabrum type derived principally from *D. consolida* L.

Among these varieties are white, all shades of blue, and shades of pink and rose.

Some of the more important perennial species, from which many varieties grown largely in Europe have been developed, are as follows:

Delphinium grandiflorum is a native of Siberia and probably includes more varieties than any other in cultivation. It makes a splendid border plant, growing from 2 to 3 feet high, with good foliage throughout the season even in hot weather. The typical flowers are large and blue, but there are white varieties, and all have long and taper-pointed spurs. Violet occurs on the lower petals of some kinds and often yellow on the upper petals. There are many double forms.

Delphinium hybridum is an Asiatic species with blue flowers which have white beards on the lower petals and long spurs. It is the tallest and most robust of the popular species, has many double and semi-double varieties, and responds to fertilizing and cultivation.

Delphinium exaltatum Ait. is a native of the Mississippi Valley and eastward and is a most desirable cultivated plant. It grows to a height of 4 feet and has blue flowers which have some yellow on the upper petals. It grows wild on the edges of woodland, suggesting that it may be grown with a little shade, either in the border or naturalized.

Delphinium fissum Waldst. and Kit (see cover illustration), like the three preceding species, has a number of named varieties. It, too, is tall, possibly being slightly taller than *D. exaltatum*. Its flowers are blue, with a white beard on the lower petals.

Delphinium formosum is one of the most satisfactory for permanent planting and naturalizing because of its hardiness. It grows 2 to 3 feet high and has blue and violet flowers with long spurs.

Many varieties are attributed to the bee larkspur (*Delphinium elatum* L.), but probably most of them are forms of *D. exaltatum*. The bee larkspur also is tall, growing 6 feet high. It is a European species having many forms and is much cultivated abroad.

There are a number of varieties grouped under the name of *Delphinium cultorum* Voss, the affinities of which are by no means clear, and several dwarf species and varieties useful in rock gardens, where upright plants are appropriate.

In addition, there are a number of other interesting species, many of them natives, among which is *Delphinium cardinale* Hook., a bright-red, California species growing to a height of 3 feet and even higher under favorable conditions. Its hardiness, however, is doubtful, except in the warmer parts of the country.

In all these delphiniums the differences are more botanical than horticultural, the choice being merely a matter of personal preference. It is an interesting field for the gardener to explore, with full assurance of obtaining something worth while, irrespective of the variety selected.

DISEASES OF DELPHINIUMS

Delphiniums are subject to several troubles caused by insects, mites, fungi, bacteria, and viruses. They are also frequently victims of various defects of culture and are to be classed as flowers rather difficult of culture, most suitable for garden specialists or for those favored with especially appropriate soil and climatic conditions. The ensuing discussion of diseases covers those growth failures and plant injuries that are caused by adverse cultural factors, by fungus and

bacterial parasites, and by viruses. Information on the control of insect and related pests is given in a separate publication.[1]

ROOT ROT

Probably the most prevalent disease of delphiniums, especially of the perennial types, is root rot. This is not a specific disease having a definite inciting cause, but is a symptom complex in which the most conspicuous features are death and decay of the roots and the basal part of the stems. The aerial parts of the plant may show loss or change of color, wilting, or a general blight, but these are secondary effects of the primary damage to the root.

Environmental factors have an important influence on root rot. One of the most common cultural defects is too warm an exposure, resulting in excessively high soil temperature, deficient soil moisture, and a tendency in clay soils to become crusty and compact. Direct plant injuries also occur, such as sunburn, appearing as a silvery or bronze discoloration of the entire lower surface of leaves, and burning or withering of the leaf margins. The plant weaknesses induced by excessive heat and light intensity are communicated to the root, which may then become prey to ordinarily harmless soil organisms. In regions that are generally too warm for delphiniums, the climatic handicap can be mitigated by giving them a partly shaded site and by the use of mulches.

A second cultural defect conducive to root rot is a heavy type of soil that is not worked deeply enough and is not porous enough to air and water to provide adequate space and a congenial environment for delphinium roots. A suitable delphinium soil should be so well drained both on the surface and beneath the plants that there is no tendency for it to remain soggy or become sour. The recommendations previously given for the preparation of a planting site (p. 2) for delphiniums should be carefully observed, if root rot difficulties are to be avoided.

As contact of the crowns of delphinium plants with stable manure may promote root rot, its use as a mulch should be avoided, but it may be used in preparing the bed provided it is worked deeply into the soil before the plants are set.

If the cultural requirements of delphiniums are not satisfied, the plants may suffer from root rot even in the absence of aggressive fungus parasites, but delphiniums are also susceptible to certain parasitic organisms that may attack plants growing in relatively ideal conditions.

The most common fungus enemy of delphiniums in regions having a mean summer temperature above 65° F. (in the Eastern States from Long Island and southern Pennsylvania southward) is *Sclerotium rolfsii* Sacc., or the form known as *S. delphinii* Welch, which occurs in the northern part of this region, including central New York. Distinctive symptoms are the sudden dying of one or more shoots, which turn a tan color; the decay of the crown and roots so that plants can be easily lifted out of the soil; the development of white fungus threads conspicuously permeating the decayed parts and extending into the soil; the production on these threads of knots (fruiting bodies), which are at first creamy white in color and then become tan to dark

[1] WEIGEL, C. A., and MIDDLETON, WILLIAM. INSECT ENEMIES OF THE FLOWER GARDEN. U. S. Dept. Agr. Farmers' Bull. 1495, 54 pp., illus. 1926.

brown and vary from the size of mustard seed to that of sweet peas (fig. 3). Once established in a planting, this fungus can persist in the soil for an indefinite period, living on live or dead vegetable matter of almost any kind. It can similarly attack nearly all kinds of flowers and vegetables and even many weeds, though with varying degrees of virulence. It does not ordinarily injure woody plants, including ornamental shrubs, but may do so if the soil is heavily infested. It does not attack lawn grasses. Its natural spread occurs only underground unless carried in infested soil or on transplanted portions of diseased plants. Because of the wide range of host plants on which the fungus can multiply and because of its ability to live indefinitely in the soil, it is not practicable to control the disease in small gardens by crop rotation. However, changing a flower bed over to sod for several years or substituting woody for herbaceous plants will tend to suppress it and may exterminate it in time. The pest can be appreciably subdued merely by persistent sanitary treatment, together with frequent shallow cultivation of the surface soil so as to keep it dry.

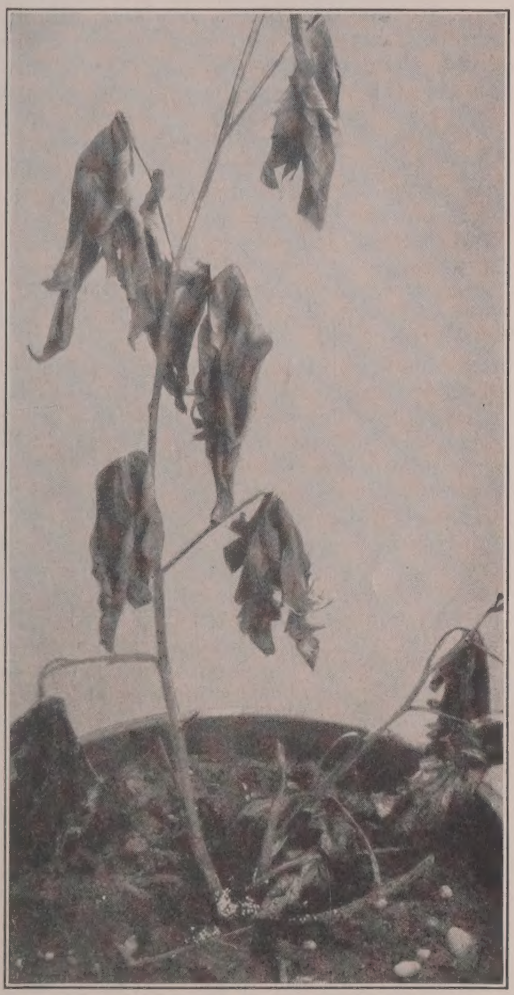

FIGURE 3.—Crown rot caused by *Sclerotium rolfsii*. Note sclerotial growth of fungus on the base of the stems.

If this fungus is detected in a delphinium bed or is known to have occurred on other plants in a bed where delphiniums are to be planted, the soil should be disinfected by any of the four methods described in the following paragraphs.

1. Remove all plants that appear entirely healthy and set them out temporarily in another bed; then spade up the first bed to a depth of 8 or 10 inches, taking out diseased roots as thoroughly as possible.

Next drench the soil with a solution of 1 part of formalin (commercial or 37-percent formaldehyde) to 50 parts of water, applying 4 or 5 gallons per square yard and follow with as much or more water until the soil is thoroughly wet to the depth of spading. Cover the bed with paper or burlap and let it stand for a week or two; then fork over the soil, to promote aeration. New plants may be set in 2 to 3 weeks.

2. Remove the plants as above, but instead of formaldehyde use naphthalene flakes at the rate of 8 ounces per square yard and cultivate them well into the soil. Cover the bed for several days, then aerate and fork over the soil, and allow at least 2 weeks to elapse before setting new plants.

3. Take out all diseased plants without removing the healthy ones; apply calomel (mercurous chloride) or yellow oxide of mercury to the soil at the rate of 1 ounce per square yard. This should be raked in well, but the bed need not be covered. A second application in 6 or 8 weeks may be necessary, and the effectiveness of the mercury treatment can be increased by the simultaneous addition of a solution of 1 ounce of sulfate of ammonia in 1 gallon of water per square yard. A fairly effective deterrent to the spread of sclerotium rot, if detected when only an occasional plant is attacked, is the application of lime and nicotine dust prepared by stirring 1 part of nicotine sulfate (liquid) into 30 to 40 parts of dry hydrated lime. This should be worked into the soil at the rate of 4 ounces per square yard. This treatment does not harm the plants.

A delphinium plant affected with sclerotium rot is unlikely to recover and is a menace to the rest of the bed if left in place or moved to another planting. Such plants should be dug out and burned, but if they are only slightly infected and are valuable enough to justify the work they can sometimes be freed of root rot by taking up the root, together with the adherent soil, and submerging it for one-half hour in a solution of 1 part of formalin in 200 parts of water, to which 10 parts of ordinary vinegar are added. This treatment is most effective in the early spring before shoot growth begins or just after the period of early summer bloom. The treated plants should be set in naturally clean or in disinfected soil.

Other organisms may also cause delphinium root rot; for example, the fungus *Rhizoctonia*, which is a common soil-inhabiting organism and a prevalent cause of root and stem rots. Defective drainage and overuse of manure seem to be predisposing factors. It is less virulent on delphinium than *Sclerotium rolfsii*, and can ordinarily be avoided by providing favorable cultural conditions.

A bacterial basal stem or crown rot of delphiniums has also been reported. The organisms have not been identified, but they apparently belong to the group of soft rot bacteria that cause such well-known plant diseases as potato blackleg and iris rhizome rot.

A black stem rot of the annual delphinium or larkspur has been proved to be caused by soft rot bacteria of the potato blackleg type. The extent to which bacterial pathogens are important in this connection and the environmental factors influencing the course of the disease have not been studied. The maintenance of good growing conditions, especially in the matter of drainage, and periodic renewal of the beds with young vigorous plants grown from seed or from cuttings may be relied on to minimize this trouble. In view of the predilection of slugs for feeding on delphinium crowns and their

demonstrated relation as carriers of pathogenic fungi and bacteria in other plant diseases, control of these pests may be expected to reduce crown infections of this type in delphiniums. Drenching the crowns with mercury bichloride solution, 1 ounce to 16 gallons of water, in the fall and spraying once or twice during early spring growth with bordeaux mixture have also been recommended.

BACTERIAL LEAF SPOT

Bacterial leaf spot (*Bacterium delphinii* (E. F. Smith) Bryan) is one of the factors in the symptom complex known as black spot or black disease. Other factors are bacterial stem rot (p. 8), the shoot and especially the flower injury caused by the cyclamen mite (*Tarsonemus pallidus* Banks), and possibly viruses of the necrotic type. Typical bacterial leaf spot appears as irregular, tarry, black spots on the leaves and sometimes on stems and buds (fig. 4). In the

FIGURE 4.—Bacterial leaf spot of delphinium.

early stages the spots are separated, being thus distinguished from the streak-like, diffuse blackening caused by the cyclamen mite. During cool, moist weather the spots may coalesce and conspicuously deform the leaves. The disease is caused by a bacterial parasite, known only in association with delphiniums. It overwinters in infected crowns, or in plant remains distributed through the soil, whence it is spread by the spattering of rain to the new leaves when spring growth is renewed. Cutting the spotted leaves in late summer or fall and drenching the crowns with mercury bichloride solution, followed by spraying with bordeaux mixture in the spring are advised for control.

MILDEW

The mildew fungus (*Erysiphe polygoni* DC.) may attack delphiniums as well as numerous other plants, causing the development of grayish-white, moldy patches on the leaves. Severely affected leaves may turn yellow and droop, but ordinarily the plant as a whole is merely weakened without being conspicuously damaged. The disease occurs chiefly in humid regions; in damp, shady sites; and on mature plants after active growth has ceased. Where delphiniums persistently suffer from mildew the soil drainage should be looked to, the air circulation

improved if practicable, and shade reduced or eliminated. Ordinarily cleaning the beds of fallen leaves and other plant debris and the maintenance of good general growing conditions will hold mildew in check. In some situations one to several applications of dusting sulfur or a wettable sulfur spray just before the spring and fall blooming periods may be necessary.

BLIGHT OF ANNUAL DELPHINIUM

The annual delphinium or larkspur is susceptible to sclerotium root rot and to bacterial stem rot (p. 18). It may also be attacked by a fungus (*Diaporthe arctii* (Lasch.) Nitsch.), which is unknown on the perennial delphiniums. This disease is characterized by premature withering of the basal leaves at the approach of flowering and the development of patches of dead tissue on the stem at the point of leaf attachment. Subsequently fungus fruit bodies, appearing as small black points, develop on the dead stems and seed capsules. As the plant is an annual, it will usually be too badly affected before the disease is detected to save, and control measures consist merely of protecting neighboring plants. Selection of seed from disease-free sources and change of planting site or soil should suffice for control.

STUNT OR MOSAIC

Several types of virus disease of delphiniums have been recorded, but whether they are different manifestations due to one virus or result from different virus infections has not been determined. A virus disease is an infectious, usually systemic malady, characterized by a blanched, mottled, or streaked condition of the foliage, with which no microscopically visible organism is causally associated. The disease entity multiplies within the plant tissues and affects all new growth and is thus perpetuated in all vegetatively propagated offspring. Some viruses are also transmitted through the seed. Most virus diseases are spread naturally from plant to plant through the agency of sucking insects, frequently aphids.

The symptoms in delphiniums ascribed to virus infection range from mere yellow streaking or a mottled green in the leaves to marked deformity of leaves and floral parts, with black spots or streaks of dead tissue, and a general foreshortening of stems, giving the plant a bushy stunted appearance. These extreme symptoms are like those caused by a severe infestation by cyclamen mites. In the eastern United States a mottled or streaked condition of the foliage in virus-infected delphiniums is more characteristic than general stunting, but the disease appears to be uncommon although its real importance and effects are not known.

The most prevalent delphinium virus belongs to the group of cucumber mosaic viruses. It can be transmitted to numerous other plants, including vegetables, flowers, and weeds. Thus delphiniums might either be a source of this disease or acquire it from other plants in the presence of the appropriate insect carriers. Thus far no such carriers are known on delphiniums. It is advisable to destroy plants showing the symptoms described and not propagate them by cuttings, though seedlings from them would presumably be virus free.

DAMPING-OFF

Seedlings of delphiniums, especially of the highly bred hybrids, are delicate and are prone to damp off. Poor germination and weakness of seedlings are augmented by the use of aged seed.

The soil for delphinium seedlings should be light and porous but sufficiently retentive to keep moist beneath the surface between daily or less frequent waterings. As a general precaution against damping-off, the soil should be treated with a formaldehyde dust, several proprietary forms of which are on the market; or 1 ounce of commercial formalin diluted with 5 parts of water may be thoroughly mixed with 1 bushel of soil. The treated soil should be placed in the flats and held for 1 day before the seed is sown; it should then be watered liberally.